have been made (1) to ascertain the elastic and ultimate strength, softness, and ductility under pulling stress; (2) to ascertain the effects produced by drilled holes and by punched holes under pulling stress; (3) to ascertain the resistance to, and effect under, bending stress. The facts elicited in these experiments, which are very voluminous, will convince the Admiralty that they should at least give Krupp's plates an equal position with the Yorkshire ones.

CAST IRON.—In round numbers, the strength of cast iron in *compression* equals the square of the tensile force, or, in other words, the resistance that cast iron of good quality gives to a crushing or compressive strain is variously stated by authorities on the subject at from 40 to 43 tons per square inch of section, and from 6 to 8 tons per sectional inch for a tensile or stretching strain. Tabulated it stands :—

	Breaking Strain.	Safe Working Strain.
In compression	40 to 48	7 tons
In tension................	6 to 8	1½ "

It is clear from this that cast iron of good quality may in compression be strained to one-sixth of its greater strength, and in tension to about one-fourth. Cast iron of good quality will, when first broken, have a crystalline texture, and a slight indentation will be made if struck smartly with a heavy hammer. Sometimes this metal is specified to bear a tensile strain of 2½ tons before loss of elasticity, and 6½ tons per square inch before fracture. Test-bars should be run each day as the castings are being made, and a good plan is to specify that the test-bars must be cast on to the ends of the castings. One test is, that a bar, 2 in. deep × 1 in. wide, placed on bearings 3 ft. apart, with a load of 25 cwt. placed on the centre, should give ¼ in. deflection and carry 27 cwt. without breaking. A second test is that of a bar, 1 inch square, placed at 4 ft. 6 in. bearing. In this test the bar should not break with a less load than 600 lb. placed on the centre. The above tests are for iron to be used in compression. When required to be used in tension, even higher standards are advisable. Some engineers insist that these shall be *dead weights*, and that no strain shall be applied in any way by levers; and in important contracts test-bars must be cast in duplicate, one to test, and the other marked with the date when run, and kept for future reference by the engineer. The area of the flanges of cast-iron girders should be in the proportion of 6 or 7 to 1; but the upper flange, where the girder is isolated, and not held in position by the structure itself, should be proportionally wider, according to each particular case, as it has to resist flexure, which would possibly deform it before compression of the flange could occur; but where the web and the upper flange are supported by the structure itself, as in the cases of arches and flooring, the above proportion may be taken. As a general rule, we may, in designing cast-iron girders, make the depth from one-twelfth to one-sixteenth of span; bottom flange, two-thirds to three-fourths the depth in centre; top flange, one-third to one-half the width of bottom; maximum span, 25 ft. With greater spans than this wrought iron becomes as economical, and safer. I believe some of our members are of opinion that strengthening webs or ribs should not be cast in girders, as the metal is drawn away from the flanges in cooling; others say that at the junction of web and flange, the rib, if broken away, will frequently be found honeycombed.

USEFUL RECIPES FOR THE SHOP, THE HOUSEHOLD AND THE FARM.

If the globes on a gas fixture are much stained on the outside by smoke, soak them in tolerably hot water in which a little washing soda has been dissolved. Then put a teaspoonful of powdered ammonia in a pan of lukewarm water, and with a hard brush scrub the globes until the smoke stains disappears. Rinse in clean cold water. They will become as white as if new.

Tasteful ornaments may be made of natural leaves and sprays artificially frosted. This is done by means of powdered glase, which can easily be obtained by pounding some bits of glass with a heavy hammer, care being taken to protect the eyes against flying splinters. Dip the object in thin gum water and shake the powdered glass over them. When dry, handsome bouquets can be arranged.

In consequence of numerous applications to the Publishers for single numbers of this MAGAZINE, either for samples or to replace lost ones, the Company decline supplying them for the future without the price, 25 cts., is remitted.

IMPROVED SIGNAL LOCKING APPARATUS AT WATERLOO TERMINUS.

(See page 144.)

In the accompanying drawing we illustrate the interlocking apparatus designed by Messrs. Saxby and Farmer, the well-known signal engineers, for controlling the heavy traffic of the South-Western Railway at Waterloo Terminus. The signalling apparatus at this station really governs two railways—the main road and the Windsor road, each having its up and its down line of rails. The two terminal stations include no fewer than twelve platform branches and several sidings, with crossings from one to the other of these branches. Nor are the operations confined only to regulating the movements of arrival and departure trains; many of these trains have to be separated after arriving, and remade up ready for departure under the control of the point and signal apparatus, by which one, two, or more carriages have to be changed from one position to another in a train, and all this without the possibility of a conflict between the points that lead to or from the various lines and the signals which command those lines.

Messrs. Saxby and Farmer have contrived to render it possible for two signalmen only to perform all these operations. The apparatus is erected in a glass-house upon a bridge which spans the four main lines a short distance in advance of the station. It consists of 109 levers arranged in a row extending the whole length of the signal-house. These levers constitute two systems, each presided over by only one attendant. On the right hand is the system for the main line, consisting of fifteen point levers, thirty-five signal levers, and five setting or locking levers, making a total of fifty-five levers. On the left hand is the system for the Windsor line, consisting of twelve point levers, thirty-one signal levers, two bolting levers, four setting or locking levers, and five spare levers, making a total of fifty-four levers. Thus the one of the two signalmen has fifty-five levers and the other has forty-nine levers to operate with. But the mere working of the levers is only a part of his duty. He has to observe through the glazed sides of his house the positions of trains moving inwards and outwards, or standing to be separated or made up; he has also to attend to signals transmitted from other signal stations, and he has to transmit electrical signals to them. On the main line side, besides the fifty-five levers that have to be worked, there are nine disc signals and eight electric indicators to be attended to, and seven knobs or handles for transmission of electric communications. On the Windsor side, in like manner, there are seven disc signals, five electric indicators, and three electric knobs. The signalmen therefore, besides noticing what passes on the railway beneath them, have to work or observe, the one seventy-nine and the other sixty-four separate instruments, all of which are so skilfully contrived and arranged that neither the strength nor the attention of the men is overtasked.

As the ultimate strength of a chain is that of its weakest link, so the duty of such apparatus as that at Waterloo is to be measured not by the average work that it has to perform, but by the strain of its busiest hours. Some idea of that strain may be formed from the following figures: — On the Thursday of Ascot week no less than 515 up and down trains, engines, and empties passed the Waterloo signal-box. On the August Bank holiday 553, and on Whit-Monday 556 have passed. Each passage requires on an average, to ensure its safety, sixteen electrical movements of the point and signal levers, so that on the busiest day of twenty working hours more than 3300 lever movements and about 8900 electrical movements have to be made, giving a total of more than 600 per hour, or ten per minute, besides those required from time to time for shunting, making up, or separating trains. But even those numbers, considerable as they are, do not express the maximum work which at certain morning and afternoon hours daily has to be performed. For example, during half an hour about 5 p. m. daily, the lever movements and electrical signals given and received succeed each other so rapidly that in every minute more than twelve distinct actions demand the labour or the attention of the signalmen in the box.

When it is considered that all this work is effected, and without any undue pressure, by two men, we think it must be conceded that Messrs. Saxby and Farmer have played an important part in facilitating the working of our great railway systems. The great peculiarity of the new system of locking is that that locking is effected not by the motion of the signal or point lever, but by that of the detent, so that the moment a lever is grasped, and before it can be moved at all, the locking is effected. The arrangement is so clearly shown in our engraving as to render further description unnecessary.—*Engineer*.